BARKLEY LAKE SYMPOSIUM

HISTORY AND ORGANIZATION OF THE BARKELY LAKE ROTENONE STUDY

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Abstract: A cooperative study was conceived, organized and implemented by the Reservoir Committee and its member agencies, Southern Division, AFS. The Crooked Creek Bay (85 ha) of Barkley Reservoir was divided into various cove and open-water areas and treated with rotenone. Overall. 990 kg/ha of fish were recovered.

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HISTORY

The Reservoir Committee, Southern Division, American Fisheries Society, was formed in 1958 to coordinate reservoir fishery research and management problems with the Southern Division states. Among its varied activities, the Committee has taken an active lead in the development and evaluation of fish sampling techniques in reservoirs. A sub-committee working under the chairmanship of Surber (1960) proposed a standard format for collecting and reporting data from cove sampling with rotenone in reservoirs. These recommendations have been widely used by many southern fishery agencies.

In September 1965, the member agencies of the Reservoir Committee conducted a cooperative evaluation of cove sampling techniques in the Perry Branch arm of Douglas Lake, Tennessee. A major objective was to describe relationships of cove samples to a much larger area of a reservoir. By sampling all coves and the open water of the 46-ha arm, workers were able to establish relative recovery rates of fish between cove and adjacent openwater areas, to obtain information on variation between individual coves, and to describe variability resulting from the size of coves sampled. The study (Hayne et al. 1968) indicated that standing crop estimates from cove samples provided reasonable approximations of the total standing crop in the larger area of a reservoir. When compared by species and size class, the cove samples either over-estimated or under-estimated the abundance of a species in the entire arm. The authors concluded that a single inflation factor for adjusting cove samples to the entire population was not practical. It was recommended that the study be duplicated under different environmental conditions to test the validity of their results.

Results of the Douglas Lake study were used to adjust standing crop estimates obtained for the recently completed Predator-Stocking-Evaluation (PSE) conducted under the auspices of the Reservoir Committee (Jenkins and Morais 1977, Grinstead et al. 1977). Results of applying the Douglas Lake conversions, along with adjustments for the recovery of marked fish, indicated that standing crops of fish in southern reservoirs may be higher than previously assumed. Grinstead et al. (1977) pointed out the need to better describe the relationship of standing crop estimates from cove rotenone samples to total fish populations of a reservoir. They recognized the inadequacy of using adjustment factors derived from a single sample for all reservoirs, and stressed the need for additional studies similar to the Douglas Lake evaluation.

New sampling methods evolve slowly, and it does not appear likely that the next few years will produce a replacement for the cove rotenone technique for estimating standing crops of fish in reservoirs. Continued emphasis on standardization of existing sampling results provides the greatest promise for prompt solutions to many current management problems. The sampling of a large area with rotenone also provides a good opportunity to evaluate several indirect methods of fish stock assessment.

On 15 July 1975, Reservoir Committee members expressed a need to duplicate a study similar to the rotenone sample taken at Douglas Lake on a mainstream reservoir. During

its 2 June 1976 meeting the Committee decided to have for its next project a large rotenone study on a mainstream reservoir. During the 25 October 1976 committee meeting Crooked Creek Bay on Lake Barkely, Kentucky, was selected as the study site for a September 1978 sampling date. Hearings were held in September 1977 near the selected study site and met with favorable public approval. Objectives and general plans were then approved during the October 1977 meeting. An Environmental Impact Assessment was prepared by the U.S. Army Corps of Engineers, revised and approved by the necessary state and federal agencies by September 1978, and submitted to the Environmental Protection Agency where it was subsequently approved prior to the sampling date.

OBJECTIVES

The following are the objectives of the study as set forth by the Reservoir Committee:

(1) To compare the standing crop of fish in coves to that of larger open-water areas.

(2) To compare results of this sample to data from the Douglas Lake study, as a means of further evaluating relations of cove rotenone estimates to total fish populations in different reservoir types.

(3) To determine variation between estimates of standing crop from replicated cove samples.

(4) To evaluate the recovery rate of fish following rotenone treatment and to test the variability of recovery in replicated cove samples through the use of marked fish.

(5) To sample two or more one-acre areas in open-water as a means of further evaluating the open-water blocknet techniques.

(6) To compare estimates of predators and available prey between individual cove samples and between cove samples and the entire sample area using the model described by Jenkins and Morais (1977).

(7) To evaluate variation in standing crop, size distribution and species composition of fish due to location of a sample cove within the study area.

(8) To evaluate alternative methods of estimating abundance of selected fish species compared to estimates based on recovery from rotenone samples.

(9) To compare standing crop, species composition and size distribution of fish near fish attractors with that the open-water area in Crooked Creek Bay.

(10) To test counting guidelines for evaluating fish kills in lakes and reservoirs as set forth by the Pollution Committee, Southern Division, Ameican Fisheries Society.

STUDY AREA

Crooked Creek Bay of Barkely Lake, Kentucky, was selected as a study site for the evaluation of the "cove-rotenone" technique. The Cumberland River was impounded by the U.S. Army Crops of Engineers in 1966 to form the 23,168 ha Barkely Lake. The investigation of a mainstream reservoir (storage ratio = 0.03) offered a marked contrast to the Douglas Lake study site. Although larger than the Perry Branch arm of Douglas Lake (85 ha compared to 46 ha), Crooked Creek Bay was much shallower, had fewer coves and was not thermally stratified.

SAMPLING DESIGN AND FIELD PROCEDURES

On 20 September 1978, blocknets were set at the mouths of Crooked Creek Bay and Shaw Bay. Largemouth bass were then tagged to determine population estimates from electrofishing recaptures and a bass fishing tournament (Harris et al. 1979). During the night of 25 September additional fish were captured by electrofishing and marked for rotenone recovery estimates. Specimens of all species of sufficient size, except clupeids, were tagged with Floy FD-68 anchor tags and released in the major area of capture.

Sub-areas within Crooked Creek Bay were chosen to evaluate different sizes of sampling areas. These areas are shown in Fig. 1 and their size and depth characteristics

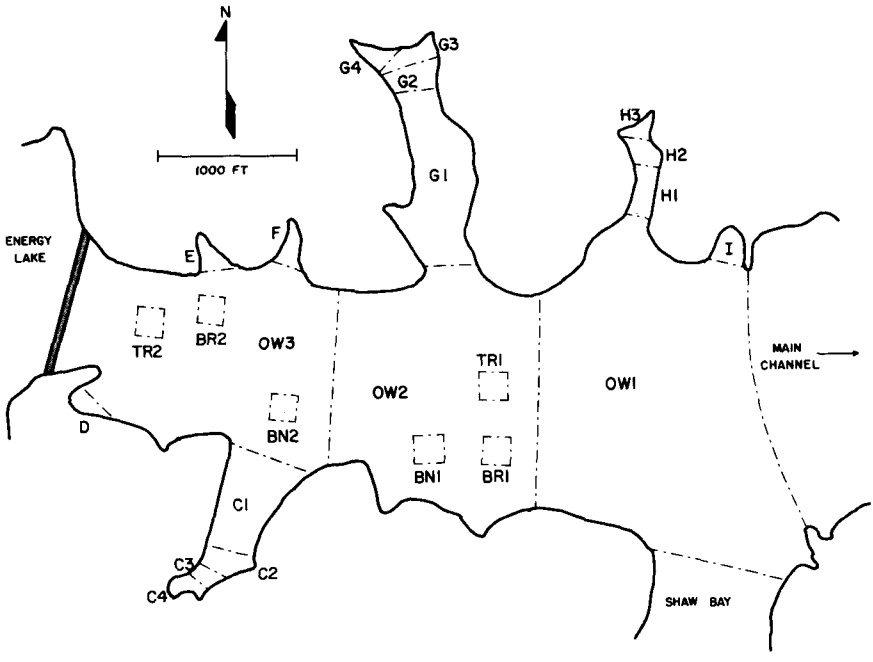

Fig. 1. Crooked Creek Bay, Barkely Lake, Kentucky, showing sampling areas. Dashed lines indicate locations of blocknets.

are listed in Table 1. Interior blocknets were set on 25 September to achieve sample sizes of 0.4-0.6 ha. Two large cove areas were also evaluated. The large open-water portion of the arm was divided into 3 sections to measure variability of standing crops in open-water areas.

Brush and tire attractors were placed in the open-water areas. One attractor of each type was placed in sections OW2 and OW3 during April 1978. Prior to the rotenone applications, these attractors were enclosed with 0.4-ha blocknets. In addition, a 0.4 ha blocknet sample was taken in both OW2 and OW3 to serve as a control and to provide an evaluation of theopen-water blocknet technique. All blocknets were set on bottom by SCUBA divers and all fabrication of large open-water nets was done prior to setting them.

On 26 September rotenone was applied simultaneously in the three major open-water areas with large, 10-cm trash pumps and on the surface with Venturi pumps attached to outboard motors. Rotenone was premeasured to provide a concentation of 1 ppm in each area. The toxicant was also applied in the 15 cove areas by smaller units pumping under the surface then spraying on the surface. Potassium permanganate was applied outside the blocknets at the mouth of Crooked Creek and in Shaw Bay to minimize the killing of fish outside the sample area. The permanganate was applied once during the first morning of rotenone application and again that afternoon.

Pick up began in each area as soon as the fish began to surface, and continued for 3 days. Separate crews were assigned to pick up or process fish in each area with secondary area assignments once their area was completed for that day. Each area had 1 to 4 data recorders and 1 or 2 crew leaders. Fish were processed within each area to minimize the crossing of blocknets and to reduce the possibility of mixing fish from different areas. All fish were sorted to species and inch groups. Aggregates weights were taken for each inch

TABLE 1. Size Characteristics of the Sampling Areas Within Crooked Creek Bay.

AREA	HECTARES	MAXIMUM DEPTH m	MEAN DEPTH m
C 1	1.60	1.83	0.96
C 2	0.62	1.52	0.94
C 3	0.41	0.76	0.58
C 4	0.44	0.76	0.43
D	0.40	1.52	1.01
E	0.42	2.59	1.46
F	0.38	2.59	1.62
G 1	5.39	4.88	1.77
G 2	0.61	1.83	1.16
G 3	0.28	1.68	0.94
G 4	0.41	1.37	0.61
H 1	0.62	2.13	1.44
H 2	0.40	1.52	0.94
H 3	0.41	0.91	0.52
I	0.39	2.44	1.00
OW 1	30.67	5.49	2.29
OW 2	20.19	5.18	2.07
OW 3	19.21	4.27	2.04
BR 1	0.31	2.44	2.13
BR 2	0.38	2.13	2.13
TR 1	0.29	2.13	2.04
TR 2	0.39	2.44	2.13
BN 1	0.35	2.44	2.13
BN 2	0.35	2.44	2.13
TOTAL	84.91		

group of each species for fish processed on the first day. Fish were not weighed on the second and third days and weights were later assigned to those fish based on the first day weights. All minnows and other small fish were weighed in aggregate, preserved and taken to the laboratory for identification. Processed fish were taken to 2 locations on each end of Crooked Creek Bay where they were loaded onto large trucks and taken to a nearby landfill especially constructed for this purpose and buried.

Because of the large number of shad and drum anticipated in Crooked Creek Bay, subsampling procedures were designed prior to the study. Subsampling was restricted to areas where the pick up of these fish was more than could be realistically enumerated in 1 day. This procedure entailed removing all large individuals of a species, determining the total weight of the remaining fish and then taking a subsample of at least 10% of the total weight. This subsample was then processed in the same manner as the other species and then used to expand the total weight of that species.

DATA PROCESSING

Upon completion of field sampling, personnel from the Reservoir and Pollution Committees proofread their field data forms; checked for legibility and descriptive

information; coded speices according to a predetermined numerical scheme; and submitted these to the Institute of Statistics, North Carolina State University, for keypunching. Data were keypunched from field sheets, and verified by the Institute. Computer listings were then prepared for all keypunched data, and returned to the appropriate committees along with the original field data sheets. Personnel from each committee then proofread their appropriate printouts against the original field data sheets, marked any remaining errors on the printout forms and returned those to the institute for final correction.

To evaluate possible errors in length-weight logic from the first days data, a computer program was developed by the Institute that identified errors either above or below expected length-weight values. These were based on length-weight relations for the Tennessee River system supplied by the Tennessee Valley Authority. Values which exceeded a predetermined measure of error were examined individually and where length-weight errors were evident, corrections were made. Following final correcion by the Institute, data from each area were reduced to total number and pounds by inch group for each fish species and each of the three days. Number and pounds per acre were also provided for each above mentioned category.

MANPOWER, LOGISTICS AND COSTS

A total of 400 people from 14 state agencies, 3 federal agencies, 2 private agencies and 15 universities participated in the field sampling of this study. The cost averaged over $522 per person providing a total field operation cost of $218,964. This cost included $10,000 for the purchase of 2500 liters of rotenone by the U.S. Army Corps of Engineers.

Area assignments were made prior to the study based on manpower and equipment availability from each agency. Equipment used included almost 5800 m of blocknet, 120 boats, 56 sorting tables, 79 weighing scales, 46 rotenone pumps, 350 kg of potassium permanganate and numerous tubs, buckets and dip nets.

The Statistics Institute, North Carolina State University, processed 3178 field data sheets at a cost of $5,500. This cost included keypunching, personnel and computer time. Additional costs for data processing were assumed by individual state and federal agency committee members in preparing detailed reports on the study.

GENERAL FINDINGS

Over the three days of fish pick up 3,072,840 fish totaling 83,133 kg were processed. More than 64 species were collected, producing an overall biomass of 990 kg/ha. Gizzard and threadfin shad comprised over 85% of the total number and 38% of the total weight (Table 2).

These numbers should not be confused with standing stock estimates since marked fish recovery values were not applied. However, of the 983 marked fish introduced into the various coves and open-water areas, 877 were recaputed during the study. This produced an overall return of over 89% indicating an excellent recovery of the standing stock during the three days of fish pick up.

Only general procedures and findings have been presented here. Details are reported in additional papers by Reservoir and Pollution Committee Members.

ACKNOWLEDGEMENTS

The Reservoir Committee expresses its sincere gratitude to those member state, federal and private agencies and universities who assisted in this project. Special recognition is extended to the Tennessee Valley Authority, the Tennessee Department of Conservation and the Kentucky Department of Fish and Wildlife Resources for their generous contribution of equipment and manpower. Also to the U.S. Army Corps of

TABLE 2. Sum of all Fish Recovery by Species from all Sampling Areas of Crooked Creek Bay. Names follows usage of American Fisheries Society list of Common and Scientific Names of Fishes, 3rd ed.

SPECIES	TOTAL NO.	TOTAL WT. (kg)
Paddlefish	100	660.4
Spotted Gar	15	3.9
Longnose Gar	2	0.3
Shortnose Gar	2	0.5
Bowfin	5	18.5
American Eel	7	3.8
Skipjack Herring	1537	162.4
Gizzard Shad	1,875,897	24797.6
Threadfin Shad	785,356	7245.1
Hybrid Shad	67	0.8
Goldeye	14	4.2
Mooneye	47	2.5
Grass Pickerel	2	0.01
Carpsuckers	92	112.2
River Carpsucker	346	387.0
Quillback	159	141.7
Highfin Carpsucker	29	33.1
Spotted Sucker	1120	203.1
Smallmouth Buffalo	2617	5400.6
Bigmouth Buffalo	1822	6320.5
Black Buffalo	185	659.1
River Redhorse	20	4.1
Black Redhorse	1	0.1
Golden Redhorse	2	0.7
White Catfish	1	0.1
Blue Catfish	2011	539.8
Black Bullhead	565	37.7
Yellow Bullhead	870	41.0
Brown Bullhead	40	7.2
Channel Catfish	18475	3974.2
Tadpole Madtom	3424	4.2
Flathead Catfish	143	151.8
Pirate Perch	1	.0
Topminnows	2	.0
Blackstripe Topminnow	18	.0
Black Spotted Topminnow	53	.1
Mosquito Fish	1	.0
Brook Silverside	727	1.0
White Bass	8810	716.4
Yellow Bass	3221	58.1
Striped Bass	4	0.01
Bluegill	49960	1938.4
Green Sunfish	307	4.0
Longear Sunfish	30619	38.5
Redear Sunfish	47	3.1
Orangespotted Sunfish	236	1.7
Redbreast Sunfish	16	0.1
Warmouth	3745	46.3

Table 2. (cont.)

Rockbass	2	0.0
Hybrid Sunfish	4	0.0
Largemouth Bass	3950	516.8
Spotted Bass	142	4.9
Smallmouth Bass	2	1.7
Crappies	72	1.0
White Crappie	69315	3471.4
Black Crappie	663	70.6
Sauger	66	17.7
Darters	2	0.0
Logperch	321	3.6
Freshwater Drum	190,525	12745.4
Carp	9125	29238.8
Chubs and Minnows	2	0.0
Golden Shiner	441	14.7
Bluntnose Minnow	1	0.0
Fathead Minnow	1	0.0
Bullhead Minnow	1	0.0
Miscellaneous Minnows	5467	11.7
Total	3,072,840	83033.4

Engineers for the purchase of the rotenone and preparation of the Environmental Impact Assessment, to the Institute of Statistics, North Carolina State University, for the preliminary data analysis and to the Arkansas Game and Fish Commission for their funding of the preliminary data analysis special thanks are extended.

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